

careous organisms in the surface waters and of the comparative rapidity with which these remains might be accumulated on the sea-bottom.

Reef-builders starting on a submarine bank, whether prepared for them by erosion, by subsidence, or by the upward growth of organic deposits, would form reefs that must necessarily tend to assume the atoll form. The central portions of the colony or clump of coral will gradually be placed at a disadvantage as compared with the peripheral parts of the mass in being further removed from the food-supply, and will consequently dwindle and die. In proportion as the reef approaches the sea-level these central parts are brought into increasingly uncongenial conditions, until at last an outer ring of vigorous, growing coral-reef encircles an inside lagoon overlying the central stunted and dead portions. The possibility of such a sequence of events was likewise recognised by Darwin. "If a bank, either of rock or of hardened sediment," he says, "lay a few fathoms submerged, the simple growth of the coral, without the aid of subsidence, would produce a structure scarcely to be distinguished from a true atoll."¹

As the atoll increases in size the lagoon becomes proportionately larger, partly from its waters being less supplied with pelagic food and therefore less favourable to the growth of the more massive kinds of coral, partly from the injurious effects of calcareous sediment upon coral-growth there, and partly also from the solvent action of the carbonic acid of the sea-water upon the dead coral. The solution of dead calcareous organisms by sea-water is undoubtedly one of the most interesting facts brought to light by the naturalists of the *Challenger* Expedition.

Moreover, a connected chain of atolls might be formed on a long, submarine bank, and similar conditions of growth would then be displayed as in the case of a single atoll. The marginal atolls having a better supply of food would grow more vigorously than those towards the centre, and would tend to assume elongated forms, according to the shape of the bank beneath them. Many of them might coalesce, and might even ultimately give rise to one large atoll. Such a chain of atolls as that of the great Maldivian group may be thus explained without the necessity for any dismemberment by oceanic currents as Darwin supposed. On the other hand, the submerged coral-banks of the Lakadivah, Caroline, and Chagos archipelagos may be regarded as representing various stages in the growth of coral-reefs, some of them being still too deep for reef-builders, others with coral-reefs which have not yet quite grown up to the surface. But scattered among these banks are some of the most completely formed atolls. Mr. Murray contends that it is difficult to conceive how such banks can have been due to subsidence, when their situation with respect to each other and to the perfect atolls is considered. He reverses the order of growth as given by Darwin, who cited the great Chagos bank as probably an example of an atoll which had been carried down by a subsidence more rapid than the rate at which the corals could build upwards.

From a careful study of barrier-reefs Mr. Murray concludes that, in their case also, all the phenomena can be explained without having recourse to subsidence. He found from personal observation and a comparison of the Admiralty charts that most exaggerated notions prevail regarding the depth of water immediately outside the reef, which is usually supposed to be very great. After minutely exploring the barrier-reef of Tahiti, and sounding the water both inside and outside the reefs, he found that the slopes are just such as might be looked for on the supposition that the corals have grown up without any sinking of the bottom. The accompanying section (Fig. 1), drawn to a true scale will show that there is nothing abnormal in the declivities. Beginning near the

shore or wherever the bottom whether of rock or sediment comes within the range of the reef-builders, a barrier-reef grows vigorously along its outer face, while its inner parts, as in the case of an atoll and for the same reason, are enfeebled and die. The force of the breakers tears off huge masses, sometimes 20 or 30 feet long, from the face of the reef, especially where from the borings of mollusks, sponges, &c., the coral-rock has been weakened. These blocks tumble down the seaward face of the reef, forming a remarkably steep talus. It is this precipitous part of the reef which has probably given rise to the notion that the water outside suddenly descends to a profound depth. The steep front of fallen blocks is succeeded by a declivity covered with coral sand, beyond which the bottom slopes away at an angle of no more than 6°, and is covered chiefly with volcanic detritus. Mr. Murray insists that any seaward extension of the reef must be on the summit of the talus of broken coral. The reef will gradually recede from the shore of the island or continent, and will leave behind here and there a remnant to form an island in the slowly broadening lagoon-channel.

The very general occurrence of proofs of elevation among the regions of barrier-reefs and atolls is in harmony with the volcanic origin of the ground on which these coral-formations have grown, but is, as Mr. Murray contends, most difficult of explanation on the theory of widespread subsidence. He affirms that all the chief features of coral-reefs and islands not only do not necessarily demand the hypothesis of subsidence, but may be satisfactorily accounted for, even in areas where the movement is an upward one, by the vigorous outward growth of the corals on the external faces of the reef in presence of abundant food, by their death, disintegration, and removal by the mechanical and chemical action of the sea in the inner parts, and by the influence of subaërial agencies and breaker-action in lowering the level of the upraised areas of coral-rock.

ARCH. GEIKIE

(To be continued.)

NOTES

IT will be seen from our Diary that the meeting of the Linnean Society on December 6 is to be exclusively devoted to the reading of a posthumous essay on Instinct by the late Mr. Darwin. We are informed that this essay is full of important and hitherto unpublished matter with regard to the facts of animal instinct considered in the light of the theory of natural selection; and as the existence of the essay has only now been divulged, we doubt not that the next meeting of the Linnean Society will be of an unusually interesting character.

THE death is announced, at the age of seventy-six, of Mr. John Eliot Howard, F.R.S., well known as a chemist and quinologist. He was the son of Mr. Luke Howard, F.R.S., a well-known meteorologist in his day.

WE announced some time ago that the Finnish Senate had voted a sum of 37,000 marks to Prof. Lemström for the continuation of his experiments with the aurora borealis at Sodankylä in the Finnish Lappmark during 1882-83, of which he gave an account in NATURE (vol. xxvii. p. 389). The plan to be followed during the present winter at this station is to make observations three times in every twenty-four hours, with the exception only of the first and fifteenth of every month, when they are made every five minutes throughout the twenty-four hours, and three days of the month when they will be effected every half minute during two hours. In order partly to obtain the necessary data for the control of the variation of the current from the atmosphere with the latitude, and partly to reduce the effect of probable influences, a branch station will be temporarily established during the months of November, December, January, February, and part of March at the buildings of the Kultala gold

¹ *Oph. cit.* p. 134.

works, some distance from the principal station at Sodankylä. At Kultala exhaustive experiments will be made as to the effect which the increase of the area of the "utströmnings" apparatus, invented by Prof. Lemström for producing the aurora borealis, has on the intensity of the current. The observations will in other respects be the same at both stations. At Sodankylä they will be continued until September 1, 1884.

THE Report by the Board of Trade on their Proceedings and Business under the Weights and Measures Act, 1878, for the past year has been issued. The following are some of the leading points in the Report: During the past year the Standards Department has had the opportunity of assisting the United States Government in a comparison of their standard of length (Yard No. 57), with the standards at this office. Prof. C. S. Peirce, of the United States Coast and Geodetic Survey, came to London for this purpose in June last, on behalf of Prof. J. E. Hilgard, who has charge of the Bureau of Weights and Measures at Washington. A large number of comparisons of these measures was made with all possible care, and it was found that at 62° F., Yard No. 57 was 0'000022 inch longer than the Yard No. 1 deposited at this office. The results of these comparisons, as calculated by Prof. Peirce, will be referred to in a printed memorandum which will be separately drawn up. It was found necessary to test the accuracy of the standard kilogram, and the only resource was to apply to the Comité International des Poids et Mesures for permission to compare the British standard kilogram with that deposited at their bureau near Paris. By the report of this comparison, it is seen that our standard kilogram is now 2'0178 milligrams too light. The Report rather naïvely points out that, but for the courtesy of the Comité, the Standards Department would have been unable to re-verify our unit of metric weight, as this country is not represented on the Comité, and consequently does not contribute towards its expenses. In a previous Report it is also pointed out that the Board of Trade had been then able to avail itself of the results of the scientific researches which had been carried out under the directions of the Bureau. A note on the instrumental equipment of the Bureau of the Comité International is attached to the Report; of the equipment of this Bureau we recently gave a detailed description. The tables of densities and expansions hitherto in use at the Standards Office not having been found entirely in accord with the most recent scientific research, new tables have been drawn up for future use in the accurate comparisons of standards of measure and weight, and these are given in the Appendix. At the last annual trial of the pyx, the Report states, the differences in weight and fineness of the new coins then submitted for testing were again found to be far within the legal amounts allowed, particularly on those allowed in the fineness of the gold coin. With reference to the Electric Lighting Act, the Report remarks that with the advance of science there arise from time to time measures and weights of new forms and denominations which, in their application to commercial purposes, subsequently receive the sanction and force of legislative enactment. Among the most important of such new measures are those for the measurement of mechanical and of electrical energy, as applied to the measurement of electricity under the Electric Lighting Act of last year. A present unit of measurement has been taken in Provisional Orders under this Act, which is equivalent to "the energy contained in a current of 1000 amperes flowing under an electromotive force of one volt during one hour." No practical meter of electricity capable of use in commerce and daily life has yet received official sanction. The Report and Appendices show that Mr. Chaney continues the work of his office as efficiently as his means will permit.

At the last sitting of the Academy of Sciences M. Pasteur read and commented on a posthumous paper by Dr. Thuilier

his pupil, who died in Alexandria, where he was sent in August, in order to make observations on cholera. The late Dr. Thuilier takes an intermediate position between M. Pasteur and M. Bouchardat. M. Pasteur seems not to be quite opposed to the views of his pupil.

THE German Cholera Commission are going, not, as they originally intended, to Bombay, but to Calcutta, as they consider the latter place more suitable for their investigations.

IN an official pamphlet published at Washington there is an interesting sketch of the work and history of the United States Bureau of Education. Not only does the Bureau publish reports on education in the United States, but at frequent intervals issues "Circulars of Information" containing data of great value, and in many cases-not otherwise accessible. Among other things these circulars contain information on the systems of education in nearly every civilised country, including China; the pamphlet referred to contains a useful list of all the circulars issued, with their contents.

IN the report by Dr. Daniel Draper on the New York Meteorological Observatory for 1882, it is shown that the actual hours of sunshine at Greenwich Observatory were 1245 in 1878 and 977 in 1879, when the possible hours were 4447; whereas at New York in the former year the actual hours were 2936, and in the latter 3101, when the possible hours were 4449.

THE "Howard" Medal of the Statistical Society for 1883, with a prize of 20*l.*, has been awarded to Dr. R. D. R. Sweeting, S.Sc. Cert. Camb., Medical Superintendent of the Western District Fever Hospital, Fulham, for the best essay on "The experiences and opinions of John Howard on the preservation and improvement of the health of the inmates of schools, prisons, workhouses, hospitals, and other public institutions, as far as health is affected by structural arrangements relating to supplies of air and water, drainage," &c.

THE cultivation of Sorghum (*S. saccharatum*) and the manufacture of sugar from its stems has of late occupied a large share of attention by the Government in America, reports on which have been issued at different times. The most recent of these is an "Investigation of the Scientific and Economic Relations of the Sorghum Sugar Industry." This is in the form of a report drawn up by the committee of the National Academy of Sciences, in which the subject of the cultivation, production, and manufacture of the sugar is treated in considerable detail. The report is one of considerable value, especially to those interested in the progress of this industry.

FROM Dr. King's Annual Report of the Royal Botanic Garden, Calcutta, for the year 1882-83, and Mr. J. F. Duthie's Report of the Government Botanical Gardens at Saharanpur and Musscorie for the year ending March 31, 1883, both of which have recently reached us, we learn something of the progress of botany at these botanical centres in India. It is satisfactory to note that at Calcutta considerable improvements have been effected during the year, not only in the general arrangements of the garden itself but also in the scientific department, for Dr. King informs us that "the bamboo and mat erections which used to do duty as conservatories have been replaced by three large, handsome, and efficient structures of iron, on which a thin thatch of grass is spread, and under shelter of which tropical plants thrive admirably." As usual at Calcutta considerable attention has been given to various economic plants, notably those which produce the valuable article indiarubber, and which have occupied so much attention of late. Dr. King says the cultivation of the soy bean of Japan (*Glycine soja*) has of late been pressed on the people of India, and "more in obedience to the loudness of this clamour than from a belief in its soundness" he has arranged

for a supply of the beans from Japan, which he proposes to distribute extensively for trial. Much consideration has also been given to the utilisation of the various fibrous plants. In the Lloyd Botanic Garden, Darjeeling, much damage continued to be done by the cockchafer grubs until pretty nearly every plant in the garden was killed. "The whole of the grass in the garden and all herbaceous plants rapidly succumbed to its ravages, as did many of the flowering shrubs, only the deeper rooting shrubs and trees being spared. Even the plants in the conservatories did not altogether escape; eggs of the insect having got in considerable numbers into the soil of the pots." In response to vigorous efforts to exterminate this plague about six millions of the grubs were collected and destroyed by the garden labourers, so that at the time of writing the Report it was showing signs of disappearing. In Mr. Duthie's Report it is satisfactory to find that economic plants, as at Calcutta, are largely cared for, and that the cultivation of medicinal plants and the preparation of drugs from them is being proceeded with. Amongst these may be mentioned Alexandrian senna (*Cassia acutifolia*), henbane (*Hyoscyamus niger*), belladonna (*Atropa belladonna*), &c. Additions are also being constantly made to the museum.

PART VI. of the "Herefordshire Pomona" has been issued, and Part vii. and last will be published in the autumn of next year, after the Congress and Exhibition of the Pomological Society of France, to be held at Rouen in October.

In the *Japan Mail* of August 23 and September 24, Mr. E. Knipping describes the course of two storms which occurred, one on August 17 to 20, and the other September 11 to 14. These descriptions show how very completely the Japan meteorological service is organised, and that good work is being done in the Far East in collecting data for scientific meteorology.

MESSRS. MACMILLAN AND CO. have published as one of their "NATURE Series" volumes, Drs. Gladstone and Tribe's "Chemistry of the Secondary Batteries of Planté and Faure." "About Photography and Photographers" is the title of an interesting gossipy little volume by Mr. H. Baden Pritchard, published by Messrs. Piper and Carter.

MISS J. M. HAYWARD wishes to state with reference to Mr. Denning's letter (p. 56) that she did give the hour (10.30) at which her letter was written, with the date, at the end. She adds that a clock struck ten shortly before she saw the meteor; but she thinks the clock was probably slow, as it generally is. She has no doubt it was the same meteor as that seen at Bath, Bristol, and Chelmsford about the same time.

THE additions to the Zoological Society's Gardens during the past week include two Bonnet Monkeys (*Macacus sinicus*) from India, presented respectively by Mr. H. G. Rose and Miss Morant; a Common Fox (*Canis vulpes*), British, presented by Mr. H. Vaughan; two Bullfinches (*Pyrrhula europea*), European, presented by Mr. Archibald Aitchison; four Moorish Toads (*Bufo mauritanicus*) from Tunis, presented by Mr. Frederick Bridges; twelve Ruffe, or Pope (*Acerina cernua*) from British waters, presented by Mr. T. E. Gunn; two Michie's Tufted Deer (*Elaphodus michianus ♂ ♀*), a Chinese Water Deer (*Hydropotes inermis*), two Elliot's Pheasants (*Phasianus ellioti*) from China, deposited; six Coal Titmice (*Parus ater*), British, purchased; a Spotted Ichneumon (*Herpestes nepalensis*) from Nepal, five Blue-crowned Hanging Parrakeets (*Loriculus galgulus*) from Malacca, received in exchange.

OUR ASTRONOMICAL COLUMN

PONS' COMET.—Mr. S. C. Chandler has communicated to the *Astronomische Nachrichten* his own experiences at the Observatory of Harvard College with reference to the remark-

able increase in the brightness of this comet on September 22, which has been already mentioned in NATURE (vol. xxviii. p. 624). He observed with an aperture of 6½ inches. On September 21, between 8h. 55m. and 11h. M.T. he found the comet very faint and diffuse; the central condensation or nucleus about equal to a star of 11 m. On September 22, about 7h. M.T. he was astonished to find exactly in its place a bright, clearly-defined 8 or 8½ mag. star without sensible trace of nebulosity, except with a power of only 50, giving a field of 1¼ degrees, and even with that not noticeable except with attention. It was so distinctly stellar an object that an experienced observer might have failed to distinguish it from stars of similar brightness in the neighbourhood. On September 23, at 7h. 30m., he found the physical appearance again greatly changed. The nucleus seemed spread out into a confused bright disk about a half minute (arc) in diameter, outside of which was a nebulous envelope much brighter than on the preceding night, and about one minute and a half in diameter. The comet was judged to be a half magnitude brighter than on September 22. On September 25 it appeared spread out into a confused disk two minutes in diameter, a faint nucleus or concentration of light not brighter than 11 m. So rapid an increase and diminution of light is a very unusual phenomenon; Mr. Chandler thinks that phases of this kind may be characteristic of the comet's mode of light development, as the same variation was repeated on a smaller scale on October 15, when a nucleus of about 9'3 m. appeared, which gradually dissipated on the following evenings, through expansion into the general nebulosity. The comet's distance from the sun when Mr. Chandler remarked the great increase of brightness was 2'18, the earth's mean distance being taken as unity, not the least surprising condition in the case.

In the same number of the *Astronomische Nachrichten* Prof. Schiaparelli gives some account of his observations on the physical appearance of the comet at Milan, which are of much interest in connection with those of Mr. Chandler. On September 22 he found the comet about 3' in diameter, faint and diffuse, the nucleus about 13m., but the sky was not perfectly clear; the observations for position were made at 8h. 30m. M.T. On September 23, about 8h. 13m., the comet had increased in brightness since the previous evening in an extraordinary manner; it now appeared as a star of 8 m., with a very faint surrounding nebulosity of from 1' to 1¼' diameter. The central part was not exactly a luminous point, but had a sensible diameter and indistinct outline. On the 25th it was still bright, but the nucleus of the 23rd had spread out so as to form a circular nebulosity 3' in diameter, without notable central condensation.

Comparing the Milan and Harvard observations, it would appear that the rapid increase in the light of the comet took place between September 22, at 7h. 45m. and 11h. 45m. Greenwich mean time; it remains to be seen how observations elsewhere will accord with this inference. Mr. Chandler suspected, from a comparison of his own notes with those made by the observers at Kiel and Vienna, that the increase would be found to have taken place between the European and American observations on September 22.

M. Bigourdan, of Paris, says on November 19, "The comet is a nebulosity of from sixth to seventh magnitude, with nucleus: the brightest part of the coma, that which borders on the nucleus, is not symmetrical about it; it is less extended in the angle 110°—140°, and is brightest in the angle 280°—290°." Taking the comet's theoretical intensity of light on November 19 as unity, the intensity on December 31 will be 9'5, and on January 14 (when it is at its maximum), 13'0. In the absence of moonlight the comet must be, for some time, a naked eye object.

THE GENERAL THEORY OF THERMO-DYNAMICS

THE first of the six lectures on "Heat in its Mechanical Applications" at the Institution of Civil Engineers was delivered on November 15 by Prof. Osborne Reynolds, M.A., F.R.S., the subject being as given in the title. The following is an abstract of the lecture:—

Thermodynamics, Prof. Reynolds said, was a very difficult subject. The reasoning involved was such as could only be expressed in mathematical language; but this alone would not prevent the leading facts and features of the subject being expressed